Cloud Thermodynamic Phase retrieval from the MODerate-resolution Imaging Spectroradiometer (MODIS)

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Cloud Phase Retrieval : What impact ?

Cloud Thermodynamic Phase retrieval is important for :

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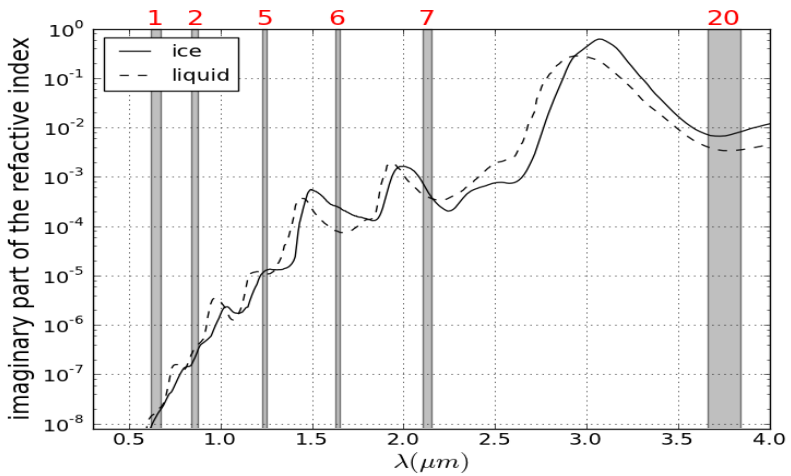

Imaginary part of the refractive index for liquid and ice particles

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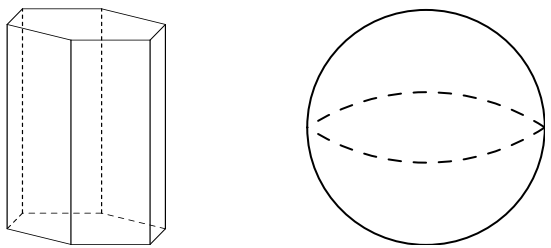

Spherical vs. non spherical particles

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- cloud and climate modelling
- cloud remote sensing.

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Why is it important for cloud remote sensing ?

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$\Leftarrow$ (fig) different optical properties between ice and liquid particles

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$\Rightarrow$ Strong impact on the MOD06 product.

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$\Rightarrow$ Cloud Phase is an important first step for the MODIS cloud optical product.

How the cloud phase is retrieved :

MODIS cloud phase retrieval algorithm is based on 6 tests [see poster] :

- 1 : Cloud Top Temperature Test (CTT test)
- 1 : Infrared Test (Infrared Tri-spectral test) [*Baum et al. (2012)*]
- 1 : $1.38\,\mu m$ reflectance Test (1.38 test)
- 3 : Cloud Effective Radius Tests (Re test) :

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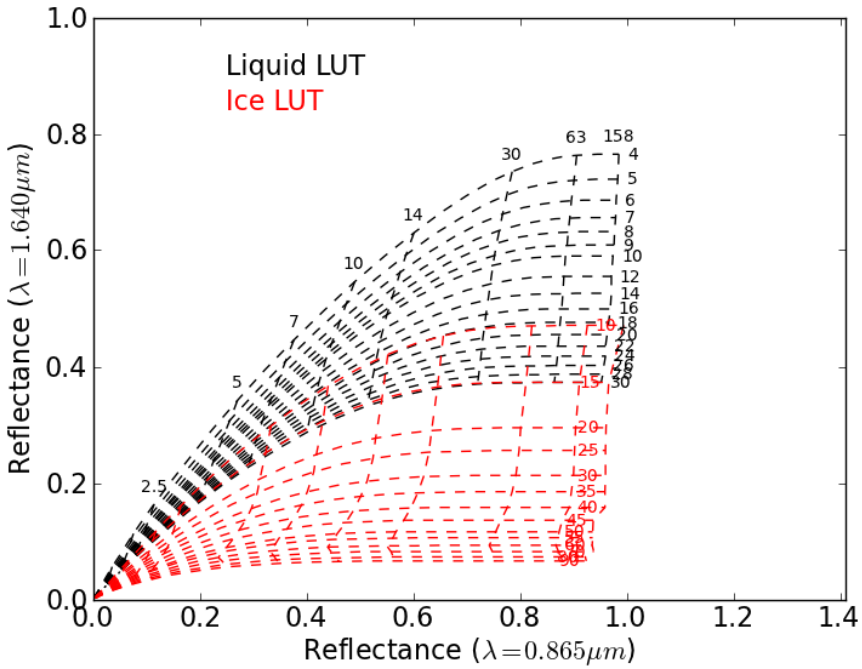

- Re retrieval at $1.6\,\mu m$
- Re retrieval at $2.1\,\mu m$
- Re retrieval at $3.7\,\mu m$

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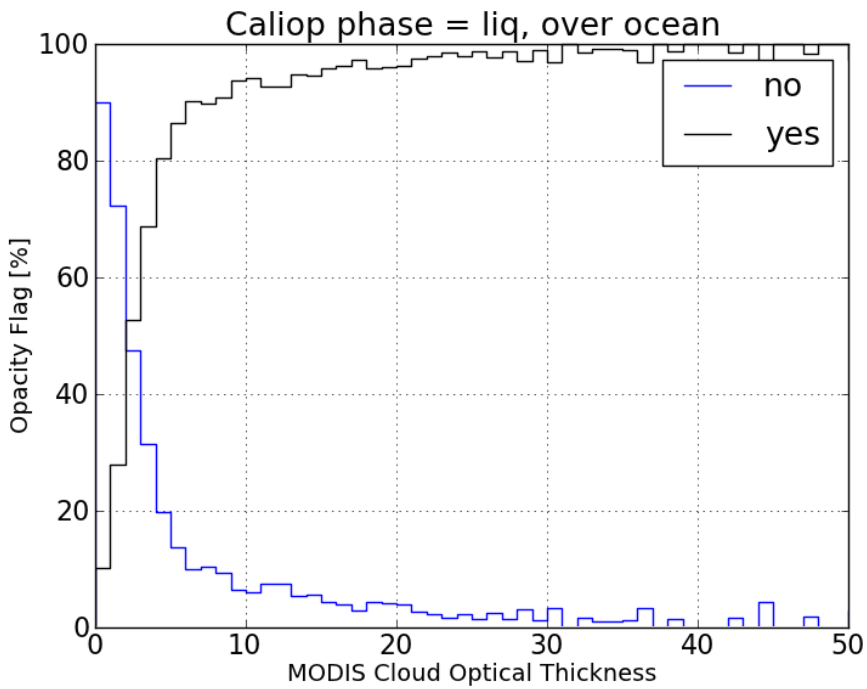
$\Leftarrow$ (fig) C5 reflectance ratio tests are replaced by Re tests.

$\Rightarrow$ Next Step : MODIS Cloud Phase assessment with CALIOP and POLDER.

Caliop-Modis Comparisons :

Which data screening has been used for these comparisons ? :

- Calipso/Caliop 1km product version 3 and Aqua/MODIS
- Caliop and Modis data from May 2007
- Caliop Version 3 of Cloud thermodynamic Phase :
  - Liquid Cloud
  - Ice Cloud (ROI Randomly Oriented Ice)



- Caliop : only one cloud layer found
- Surface flags (Modis)
- (Opt.) Opacity flags (Caliop)
- (Opt.) with/without snow/ice surface flags (Modis)

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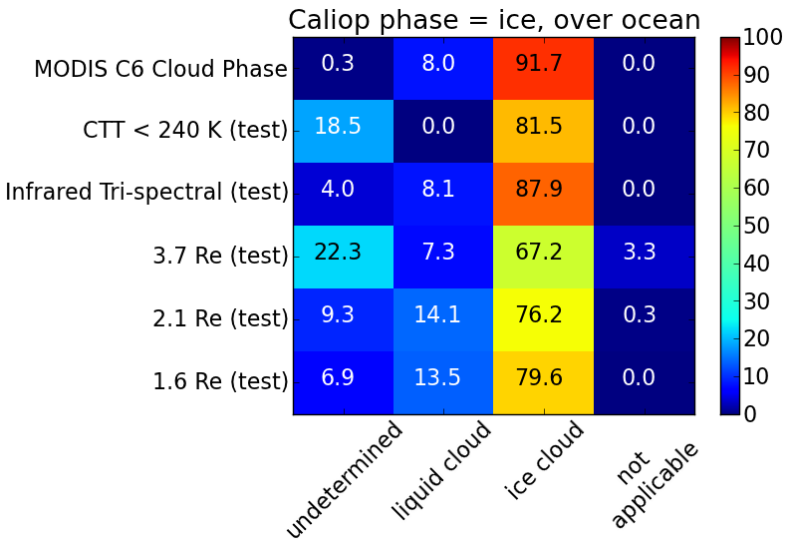
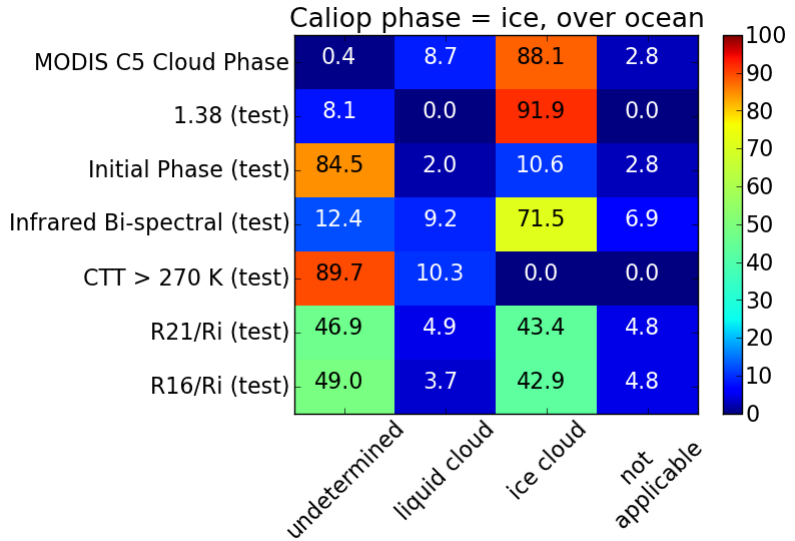
$\Rightarrow$ about 40 different data screenings

Ice Clouds (Caliop) : Over Ocean

Cloud Thermodynamic Phase retrieval comparisons between MODIS Collection 5 (C5) and Collection 6 (C6) versus CALIOP v3 (Cloud Phase = Ice) over ocean :





How to read these "Skill Tables" ? :

- table purpose : visualize the skill of each test individually
- each line is normalized to 100%
- not applicable row means : test failed or information not useful.

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$\Rightarrow$ better agreement between MODIS C6 and CALIOP for Ice Clouds over Ocean

Ice Clouds (Caliop) : Over Ocean / Opacity Flag = No

Cloud Thermodynamic Phase retrieval comparisons between MODIS C5 and C6 versus CALIOP v3 (Cloud Phase = Ice) over ocean :

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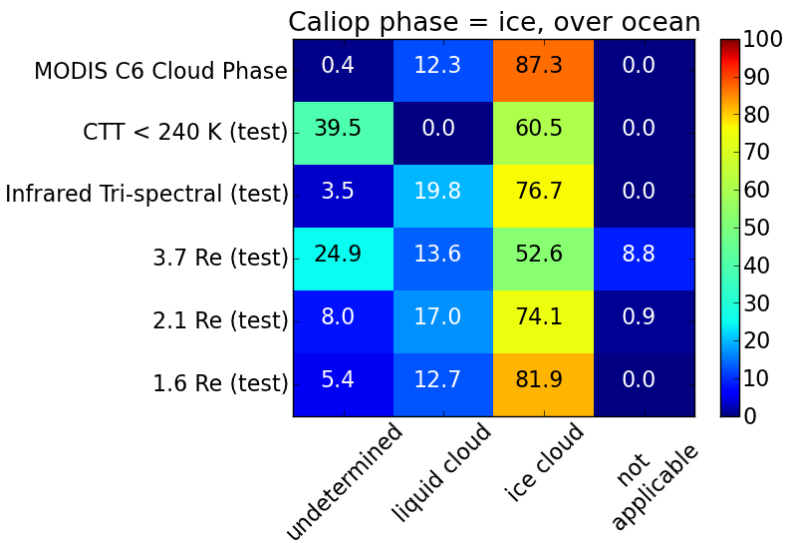
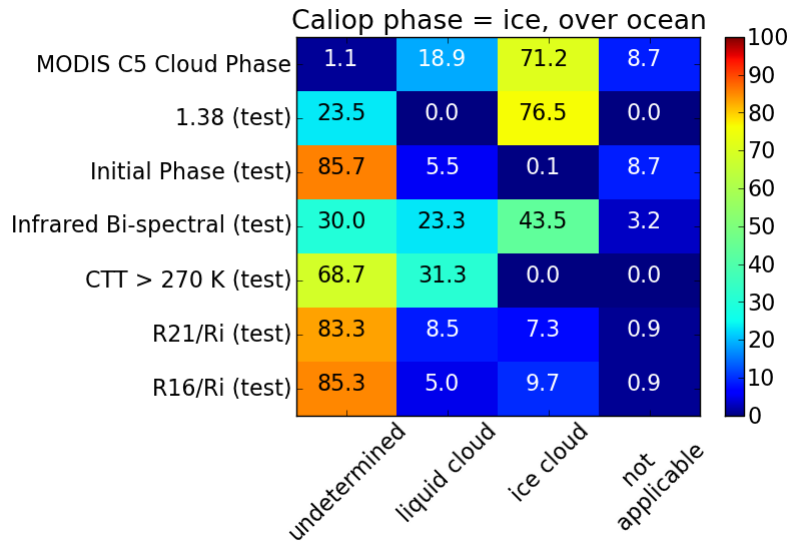
- with Opacity Flag (Caliop) = No (optically thin ice clouds)





⇒ better agreement between MODIS C6 and CALIOP for Optically thin Ice Clouds over Ocean

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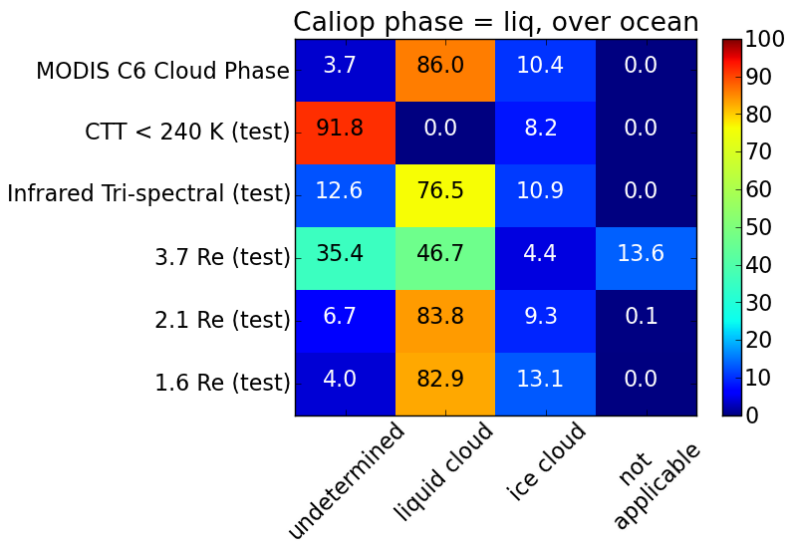
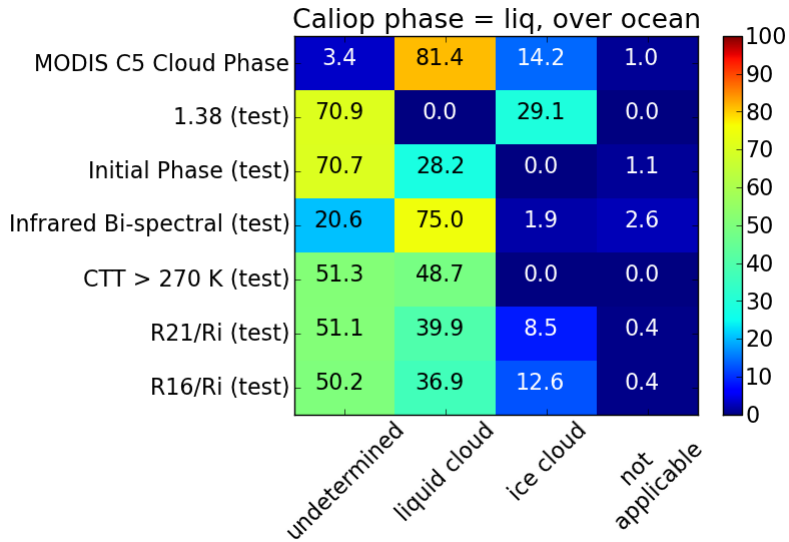
⇒ mainly due to the Re tests and the new IR Cloud Phase [*Baum et al. (2012)*]

Liquid Clouds (Caliop) : Over Ocean

Cloud Thermodynamic Phase retrieval comparisons between MODIS C5 and C6 versus CALIOP v3 over ocean :

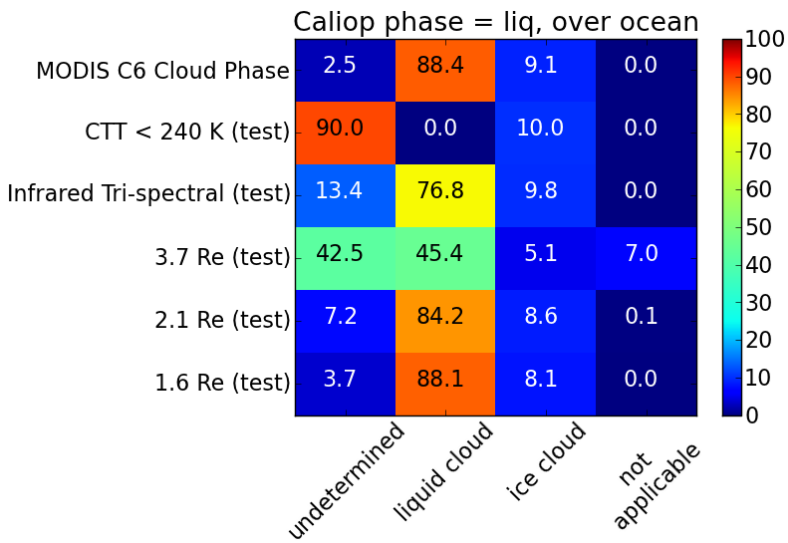


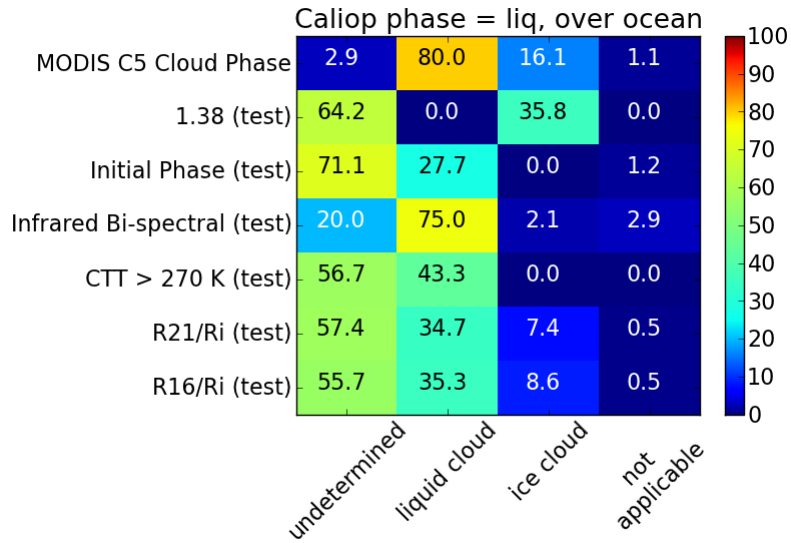


$\Rightarrow$ better agreement between MODIS C6 and CALIOP for Liquid Cloud over Ocean

Liquid Clouds (Caliop) : Over Ocean / Opacity Flag = Yes

Cloud Thermodynamic Phase retrieval comparisons between MODIS C5 and C6 versus CALIOP v3 over ocean :

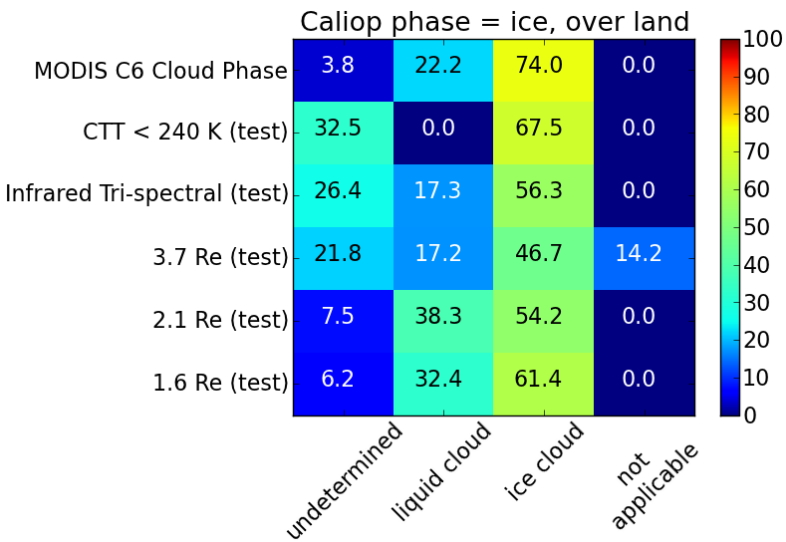


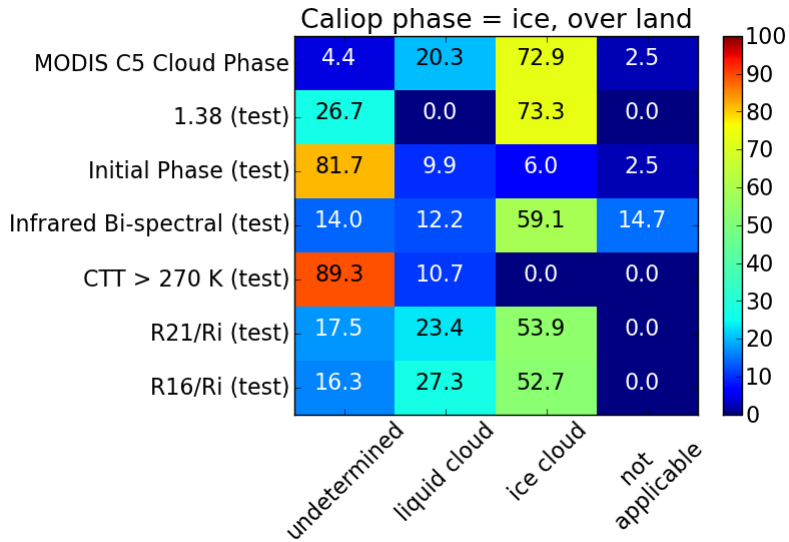


⇒ better agreement between MODIS C6 and CALIOP for Optically Thick Liquid Cloud over Ocean

Ice Clouds (Caliop) : Over Land

Cloud Thermodynamic Phase retrieval comparisons between MODIS C5 and C6 versus CALIOP v3 over land :





⇒ Up to now : agreement between MODIS C6 and CALIOP v3 for Ice Cloud over Land is about the same compare to MODIS C5 (not getting worse !).

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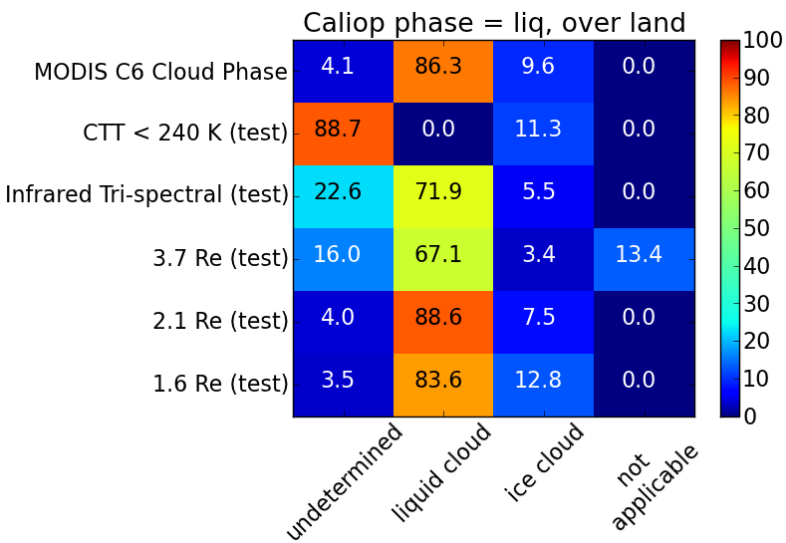
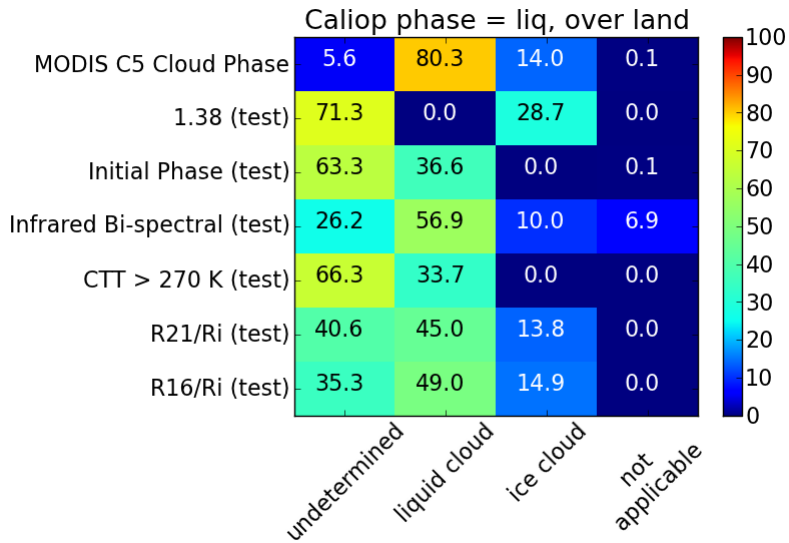
⇒ Issues come from Optically Thin Ice Clouds.

Liquid Clouds (Caliop) : Over Land

Cloud Thermodynamic Phase retrieval comparisons between MODIS C5 and C6 versus CALIOP v3 over land :





⇒ better agreement between MODIS C6 and CALIOP for Liquid Cloud over Land

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⇒ Next Step : Modis-Polder Cloud Thermodynamic Phase comparisons.

Polder-Modis Comparisons :

⇒ Modis and Polder data has been geolocated in order to compare the cloud phase retrieval from these sensors.

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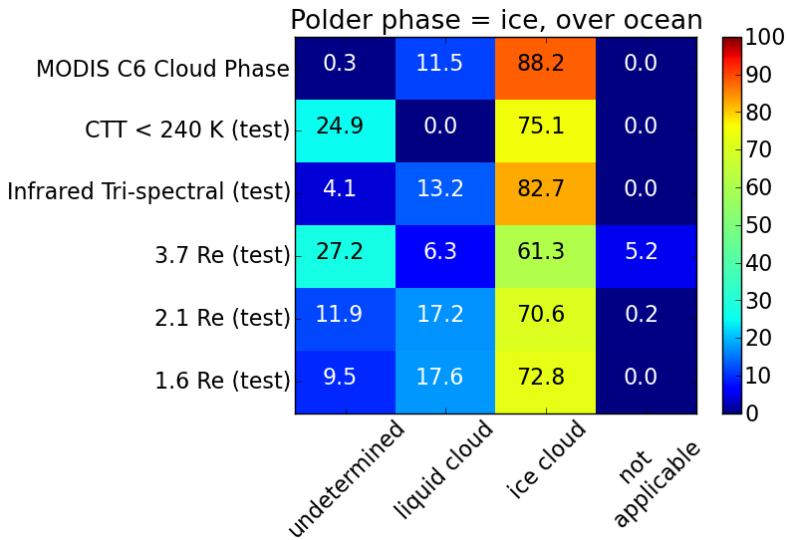
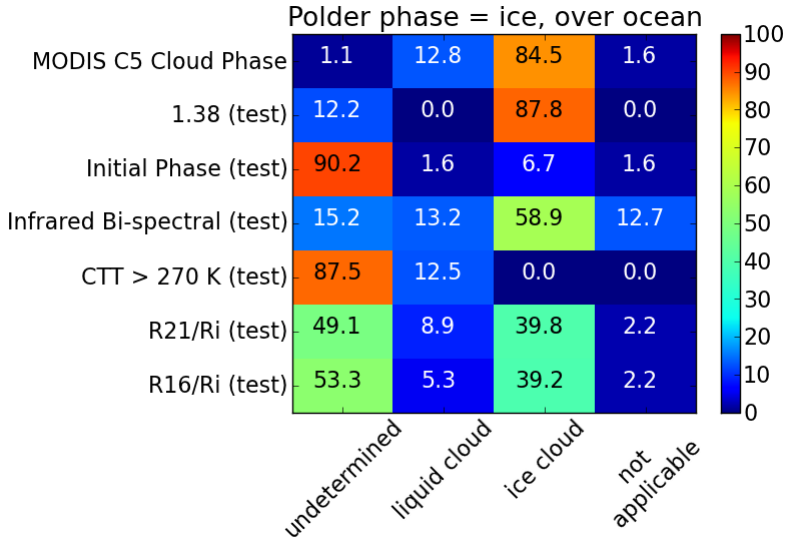
Which data screening has been used for these comparisons ? :

- Parasol/Polder-3 and Aqua/Modis
- Polder and Modis data from May 2007
- Polder Cloud thermodynamic Phase :
  - Ice
  - Liquid
  - (Polder Mixed Cloud Phase pixels are not taken into account)
- Surface flags (Modis)

Ice Clouds (Polder) : Over Ocean

Cloud Thermodynamic Phase retrieval comparisons between MODIS C5 and C6 versus POLDER over ocean :

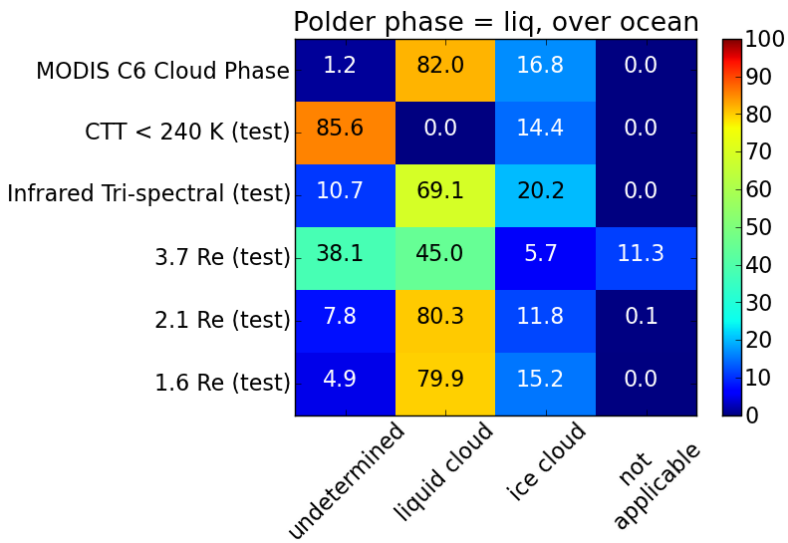


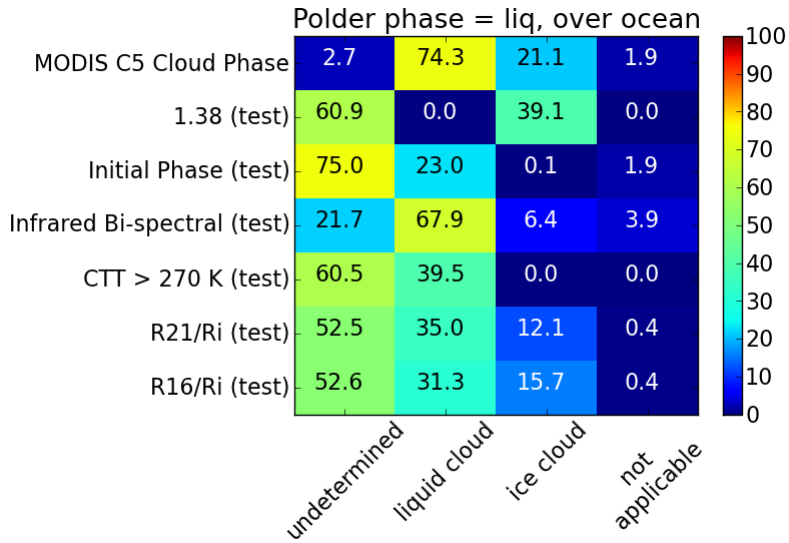


$\Rightarrow$ better agreement between MODIS C6 and POLDER for Ice Cloud over Ocean

Liquid Clouds (Polder) : Over Ocean

Cloud Thermodynamic Phase retrieval comparisons between MODIS C5 and C6 versus POLDER over ocean :





$\Rightarrow$ better agreement between MODIS C6 and POLDER for Liquid Cloud over Ocean

Conclusions :

What have we learned from Modis-Caliop and Modis-Polder Cloud Thermodynamic Phase comparisons ? :

- globally $\Rightarrow$ better agreement between Modis C6 and Caliop.
- over ocean : substantial improvement for thin ice clouds.
- good improvement for thick liquid clouds.
- first results with Polder over ocean are very encouraging as well.

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What work still remains to be done ? :

- integrate the new ice model [Ping Yang's Talk]
  $\Rightarrow$ readjust Modis Re test Thresholds.
- continue testing the Modis C6 Cloud Phase

Thank you for your attention

Questions are welcome !